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**CONFERENCE TITLE:** NDE of Aging Aircraft, Airports, and Aerospace Hardware (nd02)

**CONFERENCE CHAIR:** Ajit K. Mal, Univ. of California/Los Angeles

**ABSTRACT TITLE:** Composite materials stiffness determination and defects characterization using enhanced leaky Lamb wave dispersion data acquisition method

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**ABSTRACT TEXT:** The leaky Lamb waves (LLW) technique is approaching a maturity level that is making it attractive to practical quantitative NDE tool for composites and bonded joints. The phenomenon has been studied extensively, particularly in composite materials, since it was first observed in 1982. The wave is induced using a pitch-catch arrangement and the plate wave modes are detected by identify minima in the reflected spectra to obtain the dispersion data. The wave behavior in multi-orientation laminates was well documented and corroborated experimentally with a very high accuracy. The sensitivity of the wave to the elastic constants of the material and to its boundary condition led to several studies where the elastic properties were inverted and the characteristics of bonded joint were evaluated. In spite of the progress that was made both theoretically and experimentally, oblique insonification techniques are still academic tools and have not become standard industrial test methods for NDE of composite materials. The authors investigated the issues that are hampering the transition of these methods to the practical world of NDE and are involved with extensive studies to address these issues. This paper covers the progress that was made by the investigators in tackling the theoretical and experimental issues to solidify the foundation of the techniques and their transition to practical NDE tools. Recently, the authors modified their experimental setup to allow measuring dispersion curves at a significantly higher speed than ever recorded. A set of 20 angles of incidence along a single polar angle of a composite laminate are acquired in about 45 second. The reflection spectra are acquired in real time while filtering the high frequency noise allowing to obtain reliable data at ranges of amplitudes that are much lower than were used in prior studies. This method makes the LLW a practical quantitative tool for both inversion of the elastic properties and flaw characterization. The emphasis of the current study is on the detection and characterization of flaws. The composite is modeled as transversely isotropic and dissipative medium and the effect of flaws is analyzed and compared to the experimental data using a C-scan mounted LLW scanner. The authors also developed an algorithm that allows acquiring LLW modes that are buried in a relatively high level of noise. This capability is leading to a significant advancement in the experimental acquisition of the modes and is enabling to enhance the accuracy of the inversion as well as applying the methods that are relatively attenuative and could not be tested before.

**KEY WORDS:** Leaky Lamb Waves (LLW), NDE, Composites, Stiffness Constants, Aging Aircraft

**BRIEF BIOGRAPHY:** Dr. Yoseph Bar-Cohen is a physicist with over 27 years experience in NDE, sensors, actuators and electroactive materials. He is the Jet Propulsion Lab (JPL) Resident NDE expert and the Group Leader for the NDE& Advanced Actuators (NDEAA) Technologies. Also, he is an Adjunct Professor at the Department of the Mechanical and Aerospace Engineering, the University of California, Los Angeles (UCLA), a Fellow of the American Society for NDT (ASNT) and Chair of the ASNT's Ultrasonic Committee. Dr. Bar-Cohen discovered the leaky Lamb waves and the polar backscattering in composite materials and co-pioneered their applications to NDE. He is the author of more than 135 publications, made numerous presentations at national and international symposia and holds many patents.